MANAGING FARM PONDS FOR TROUT PRODUCTION

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Contents

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Managing Farm Ponds for Trout Production

Alfred W. Eipper

There are over 16,000 farm ponds in New York State and new ones are being constructed at the rate of about 1,000 a year. Of the various farm pond uses, fishing is one of the most popular, and many New York farm ponds are stocked with trout. Fishing is a source of recreation for the whole family, and trout are a real table delicacy.

The purpose of this publication is to discuss:

1. Factors to consider in deciding whether or not to stock trout.
2. Design and construction features particularly valuable in trout ponds.
3. Results that can be expected from a trout pond.
4. Where and how to obtain trout for a farm pond.
5. Management practices for obtaining the most trout fishing from your pond.

Information presented here is based largely on results of ten years' work on 70 ponds in Central New York State. The recommendations given should apply to farm ponds throughout New York that have surface areas up to two acres and maximum depths from seven to fifteen feet.

TROUT OR WARM WATER SPECIES?

Farm ponds may be used for trout if the water does not become too warm during summer months, or else for various kinds of fish such as bass and bluegills, that tolerate warmer water. The pond owner's choice between these two main groups of fish will be governed by various characteristics of his pond, and by individual requirements and preferences.

Water Temperature

Survival of trout in New York farm ponds is influenced more by maximum summer water temperature than by any other factor. Although farm pond trout can withstand water temperatures as high as 80°F. for periods of one or two days without undue mortality, prolonged periods of water temperature above 74°F. will cause trout to die. Therefore, how suitable a farm pond will be for trout depends chiefly on how long the coolest water, near the pond bottom, will remain above 74°F. in any one period.

Figure 1. Temperature of the pond's deepest water can be accurately measured with thermometer suspended in an empty oil can. See directions in text.

Bottom water temperature, which may differ from that of the surface by as much as 12°F., may be measured accurately with a glass thermometer suspended in a tin can, as follows (see figure 1): Make one pencil-sized hole in the top of a quart can of motor oil, empty the can and wash out the remaining oil. Punch three very small holes around the top rim of the can and attach a wire bridle for suspending it, as shown. Use an unframed thermometer with the degrees marked on the thermometer stem itself.[1] Insert the thermometer through the hole in the can and secure it with a

[1]Thermometers of this kind are stocked or can be ordered at hardware and photographic supply stores.

rubber band so that the bulb is suspended in the lower part of the can, not touching the sides.

Obtain a stout bamboo pole 15 feet long and attach a 10-foot length of heavy twine connecting the bridle to the end of the pole, as illustrated. Next fill the can with water so that it can sink. With the pole, hold the can out over the deepest part of the pond (usually about 16 feet out from the middle of the dyke) and lower it to the bottom. Leave the can resting on the bottom for at least three hours so that the water in it can reach the temperature of its surroundings. Then carefully raise the can to the surface, disturbing the water in it as little as possible, bring the can to shore, and immediately read the thermometer, keeping the bulb well immersed in the can of water. Simply lowering the thermometer alone to the bottom of the pond and then bringing it up for a reading does not give the desired results, because the reading will change as the thermometer is brought up from the cool bottom water through the warmer surface layers.

Taking a series of bottom water temperatures over a two or three week period in the hottest part of the summer (usually the last half of July) will give you an idea of what to expect from your pond. You can obtain a record of average monthly temperatures, and their departures from long-term means, in *Climatological Data–New York*.[2] Similar information may be available from your county agricultural agent. This record will provide an indication of whether the summer in which you measured your pond's maximum temperature was warmer or cooler than the average.

Source of Water

If a pond has a permanent supply of spring water—that is, if there is some water running out of the pond at all times, and the pond has a maximum depth of at least eight feet—it is practically certain to support good trout populations in any year.[3] However, many ponds fed entirely by runoff water from the surrounding watershed are excellent trout producers, although trout survival in such ponds will tend to vary more from one summer to the next. Chances of summer trout mortality in ponds fed entirely by runoff water are less in ponds located at higher elevations, ponds having a maximum depth of at least ten feet, and also those ponds that receive some shade.

[2]Available at $.20 per monthly installment or $2.50 for a year's subscription from the Superintendent of Documents, Washington 25, D.C.

[3]The only exception to this rule encountered so far was the summer of 1955, when pond and lake waters in many parts of the state reached temperatures higher than any ever recorded before.

Pond Size

At the high stocking rates which have been found possible in farm ponds, it is practical to stock those as small as one-tenth of an acre with trout. With most warm water species, however, results are likely to be unsatisfactory in ponds less than one-third to one-half acre.

Kind of Fishing Provided

Trout and warm water species differ considerably in the kind of fishing they provide. Trout ponds offer most fishing during the fall, winter and spring, since farm pond trout are usually hard to catch during the summer months. Warm water species offer more fishing during the summer.

The amount of fishing pressure expected may also affect the kind of fish to be stocked in your pond. Ponds stocked with warm water species, which generally reproduce themselves, can withstand almost unlimited fishing, particularly for bluegills, bullheads, and other very prolific species. Although trout ponds provide a great deal of fishing and in fact they are more commonly under-fished than over-fished, it is still possible to "fish out" a trout pond prematurely under exceptional circumstances. A pond that will be subject to uncontrolled fishing at any time by persons other than the pond owner and his family should usually be stocked with warm water species.

If there is some doubt as to whether to start off a new pond with trout or warm water species, it is much better to begin with trout. Trout normally do not reproduce in farm ponds and are unable to compete successfully with warm water species. Once warm water species are established in the pond, it is impossible to change over to trout without first killing off the entire warm water population by draining or with chemicals, either of which may be difficult, or in some cases impossible. On the other hand, there are no problems in switching from trout to warm water species.

POND LOCATION AND CONSTRUCTION FEATURES

The importance of proper location, design, and construction of any farm pond cannot be overemphasized. Technical assistance on these matters often can be obtained from the Soil Conservation Service, and other aid may be available through the Agricultural Stabilization and Conservation Program. Any prospective pond owner should consult his county agricultural agent for specific information on the farm pond services available in his particular county, and should obtain a copy of

Cornell Extension Bulletin 949, which thoroughly describes the design and construction of farm ponds. This section will discuss briefly only those aspects of the location and construction of farm ponds that are of particular importance to their management for trout production.

Location

A trout pond should be located at a site where sufficient depth and the best possible water supply can be obtained.

Locating the pond near the house is essential if it is needed for fire protection, and also serves to reduce the likelihood of unauthorized persons fishing or stocking the pond, either of which can have serious consequences.

No pond to be used for fish production should be located where it will receive runoff from lands regularly cultivated. Such a water supply continually brings silt into the pond. As silt deposits build up, the pond becomes too shallow. Such a pond also is likely to be constantly muddy, a condition that may reduce trout growth considerably by cutting down the production of aquatic insects, the principal food of trout.

Size, Depth, and Slope

As stated earlier, ponds as small as one-tenth acre can be satisfactorily managed for trout when high stocking rates are used. However, larger ponds will produce much more fishing. To illustrate, a one-tenth acre pond can be stocked with 60 trout but a half acre pond stocked at the same rate would receive 300 fish.

The deeper a pond is, the cooler the bottom water will be during summer months. To be successfully managed for trout, New York farm ponds with a year-round supply of spring water should have a maximum depth of at least eight feet. Seven feet is occasionally enough when springs feeding the pond are exceptionally large. The maximum depth of runoff ponds should be ten feet to give uniformly satisfactory results, although runoff ponds eight feet deep will give good results in some years. If it is planned to also use the pond for irrigation, the maximum depth should be great enough so that the irrigation contemplated will never reduce the depth below eight feet. A farm pond that leaks is unlikely to be suitable for trout unless the water supply can keep up with the leak at all seasons.

All sides of the pond should have as near to a 2:1 slope as possible out to water depths of at least three feet. There are two reasons for this. Extensive areas of shallow water warm up quickly during sunny weather, and this water, when mixed by wind action, tends to increase temperatures throughout the pond. Secondly, weed growth will practically always be-

come a serious problem in shallow areas, and keeping the total amount of shoal water to a minimum will greatly reduce weed troubles.[4]

Water Supply

In New York farm ponds fed entirely by runoff water, a five-acre watershed is generally adequate to maintain a one-acre pond. If there is some permanent supply of spring water the watershed area can be reduced proportionately. It is desirable to avoid any larger watershed than needed, since there is some tendency for trout to escape from ponds that are subjected to exceptionally large amounts of overflow. Unneeded runoff water can be kept out of a pond by constructing a diversion ditch.

Occasionally water by-passed from an adjacent stream is used to supply a farm pond. This type of water supply should be avoided in ponds to be used for trout. In many cases the stream supplying the water may become too warm during summer months, and such a water supply is likely to carry a heavy silt load at times.

Usually the most serious disadvantage of a by-pass pond to trout management is that it is a source of contamination and sooner or later other kinds of fish will be introduced into the pond, where they will act as weeds, eventually crowding and starving out the trout. Experience has shown that practically all permanent streams contain fish of some kind, whether or not they are in evidence to a person walking the bank. Horizontal screens or filters placed across the water supply to the pond are not effective in keeping out contaminating fish, since structures fine enough to keep out the smallest young fish become clogged and overflow in a very short time.

If it is essential to use by-pass water for a fish pond, it may be possible to reduce contamination to a minimum or prevent it altogether if the inflowing water can be made to enter through a pipe that is at least two and one-half feet above the maximum pond level, using a method which has been found successful in Israeli fish ponds and illustrated in the accompanying sketch (figure 2). This consists essentially of a box perhaps two feet square (varying with the volume of inflowing water) with wooden or sheet metal sides about 16 inches high. The top of this "box" is open, while the bottom consists of plastic window screening (about 15 meshes per inch) thoroughly supported from below by wooden or metal slats or similar reinforcement. This box is mounted securely on four legs so that water from the inflow pipe falls directly on the screening. The screen, in turn, should be at least six inches above maximum water level. All

[4]See Cornell Extension Bulletin 1014, *How to Control Weeds and Algae in Farm Ponds.*

Figure 2. If a by-pass water supply must be used, this box with screened bottom may keep out weed fish.

parts should be protected against rust and rot, and the construction must be very sturdy. Fish entering through the pipe are deposited on the screen, where they die either from lack of water or from being beaten against the screen by the falling water. Experience will determine how often the box needs to be cleaned of debris. This will probably vary with the season.

When a trout pond receives water from a spring, use tile or pipe to lead this water into the pond from the place where it first appears above ground. Doing this can keep the inflowing spring water as much as 15 degrees cooler than if it were allowed to trickle into the pond over an exposed area of ground. The tile need not be buried much below ground level.

Water Control Structures

A vertical pipe to take care of normal pond overflow, called a trickle tube, with its upper end at the desired water level and its lower end connecting with a horizontal drain pipe at the bottom of the pond is particularly desirable in any farm pond to be managed for fish production. This arrangement is illustrated on page 16 of Cornell Extension Bulletin 949. Although this structure adds appreciably to the cost of the pond, fish are much less likely to be lost when normal overflow runs out such a vertical pipe than when it runs out a horizontal spillway. If the horizontal spillway must be used, it is advisable to have this as wide and level as possible so that the outflowing water will be spread in a thin sheet. A

small wooden dam two to four inches high placed across the spillway may also lessen the tendency of fish to swim out of the pond when there is enough water in the spillway to permit their doing so. If a screeen is used for this purpose it should not be more than four inches high because it soon becomes clogged and acts merely as a dam.

A drain pipe is an important asset to any trout pond. If the pond becomes contaminated with undesirable fish, and its location with respect to other waters is such that a permit to eliminate these fish with chemicals cannot be obtained, draining is the only way of restoring its usefulness for trout production.

Fencing

If livestock have access to the pond, it should be fenced to keep them out. Simple structures for providing stock water outside the pond are described in Bulletin 949. Cattle wading at the pond edge tend to keep the water turbid, thus reducing the pond's fish production capacity. Furthermore, by trampling the bank they tend to destroy the sod cover, which results in erosion, increased siltation, and danger to the entire pond structure.

VITAL STATISTICS OF FARM POND TROUT

This section describes the reproduction, survival, growth, and pounds production of trout to be expected in the *average* New York farm pond. It is important to remember that individual ponds vary widely, and there is no reason for concern if the results obtained in a particular pond and year differ considerably from the figures given here.

Reproduction

With rare exceptions, farm pond trout do not reproduce, although they may go through the act of spawning. This is because most ponds lack a suitable spawning site, which for trout consists of a gravel area through which a good flow of spring water percolates during the incubation period. This supplies the eggs in the gravel with fresh, oxygen-rich water and keeps them from being smothered by silt deposits. In a very few ponds having exceptionally large and concentrated springs, limited trout reproduction has occurred naturally at times, or has been achieved by placing beds of gravel in suitable locations. To date no method has been discovered for achieving adequate natural reproduction in the average spring-fed pond without resorting to modifications and additional construction which require considerable outlays of time and money.

Survival

Brook, rainbow and brown trout all survive equally well in New York farm ponds, although brown trout are not generally recommended, as discussed in a later section (see page 16). Survival of farm pond trout fluctuates annually with changes in average summer temperature from one year to the next. In the first year after stocking, survival also varies with the size of fingerlings stocked. Fingerling trout are fish of the current year's hatch, that is, less than a year old. Under hatchery conditions, trout generally hatch out in late winter, and those stocked in the spring, at an age of about two months and a length of about two inches, are called *spring fingerlings*. Fish of the same lot that are held over in the hatchery for stocking in the fall are then called *fall fingerlings*, at which time they may be anywhere from three to seven inches long. During the first summer following stocking as spring fingerlings, the survival of farm pond trout is highly variable, averaging only about 30 percent. In the two succeeding summers, average trout survival is about 50 percent. Over-winter survival of trout in each year of pond life is commonly between 60 percent and 80 percent.

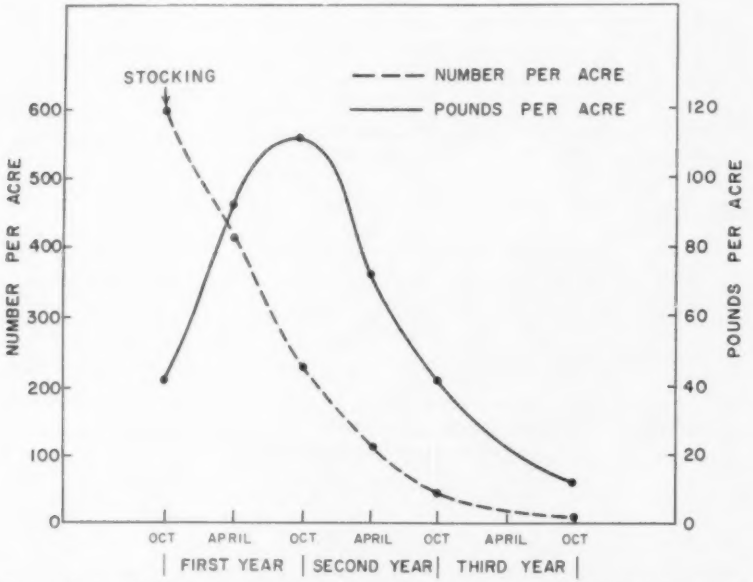

Figure 3. Numbers and pounds of trout remaining in an unfished farm pond after stocking with 600 fall fingerlings per acre.

The dotted line in figure 3 shows the average number of brook or rainbow trout remaining in an *unfished* farm pond at any given time during the three years following stocking at a rate of 600 fall fingerlings per acre. If lower stocking rates are used, similar results are obtained, the numbers of trout simply being lower throughout.

From the graph it is clear that few trout remain after three years in a farm pond, and four-year-olds are a rarity, as is also the case in most other trout waters of the State. This trout mortality from natural causes is a gradual process and takes place more or less continuously, even though the dead fish are very seldom seen.

Growth

Brook, rainbow and brown trout all grow at the same rate in farm ponds. Average lengths and weights in spring and fall of the three years *after* stocking are given in table 1. In a pond stocked with 2,000 spring fingerlings or 600 fall fingerlings per surface acre, the trout will generally average about eight inches in length by the following spring. In general, growth slows down as the fish grow older; is somewhat faster in summer than winter.

Like survival, growth rate varies considerably from one pond to the next. Trout probably grow a little more slowly in the first few months after a pond is first filled, before it has built up a supply of aquatic insect life, the trout's principal food. Also, trout are likely to grow more slowly in soft (acid) water than in hard (alkaline) water ponds, other things being equal.

Production

The total poundage of fish present in a pond at any given time is the net result of two opposing forces: (1) the death rate, which reduces total poundage, and (2) growth, which increases the poundage. In a population of fish all the same age, the total weight of the population increases when the poundage being added by growth exceeds the poundage being lost

Table 1. Average lengths and weights of farm pond trout in the first three years *following* stocking.

	First year		Second year		Third year	
	Spring	Fall	Spring	Fall	Spring	Fall
Length, inches	8.1	10.1	11.1	12.8	13.5	14.2
Weight, ounces	4	8	10	14	17	22

by reduction in numbers. When the effect of death rate over-balances that of growth, a net decrease in total poundage results. The solid line in figure 3 shows the total pounds of trout that would be present in an *average* New York farm pond at any given time during the first three years following stocking with 600 fall fingerlings per acre, if none of them were removed by fishing. Under these conditions, total poundage reaches a maximum averaging about 110 pounds per acre by fall of the first year following stocking when some 230 trout (dotted line, same graph) remain. One year after this, only 41 pounds (45) are left.

FARM POND TROUT MANAGEMENT

Information on reproduction, survival, growth and production, summarized above, provides the framework necessary for making trout management recommendations for New York farm ponds. This section describes procedures for obtaining from your pond the maximum amount of trout fishing that is consistent with reasonable cost.

Stocking

Obtaining Fish

Fingerling trout are available free of charge from the Bureau of Sport Fisheries and Wildlife, United States Fish and Wildlife Service, for farm ponds that meet certain requirements. The primary requirement is that construction features and water supply of the pond be judged suitable for trout. In addition, it must be an artificially constructed impoundment which is not less than one-fourth acre or more than five acres in surface area and does not already contain a population of fish other than trout. Ponds that are in any way connected with a commercial enterprise such as a resort, motel or recreation area are not eligible for Federal fish. If your farm pond was built in cooperation with the Soil Conservation Service, it will usually be simpler to request trout for your pond through your local Soil Conservation Service office. The Soil Conservation Service, in turn, will make application to the Fish and Wildlife Service for fish for your pond without your having to do so personally. If your pond was not built in cooperation with the Soil Conservation Service, you may apply directly to the Fish and Wildlife Service for trout by submitting Fish Application Form 3-1688, in duplicate, to:

The Regional Director
United States Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife
59 Temple Place, Boston 11, Massachusetts

Application forms may be obtained from the above address, or from your county agent or local representative of the Soil Conservation Service. *Applications for Federal fish to be stocked in a particular year must be received at the Boston Office before February 1 of that year.*

Pond owners can also obtain trout from various commercial hatcheries in New York and neighboring states. A list of these hatcheries is available from the:

New York State Conservation Department, Bureau of Fish
Albany, 1, New York

Before fish from a commercial hatchery can be stocked in any farm pond or other water, permission to do so must be obtained from the State Conservation Department through your district fisheries manager.[5] The pond owner need not do this if the fish are obtained through the Soil Conservation Service or directly from the Fish and Wildlife Service, since these applications are automatically forwarded to the State Conservation Department for approval.

A substantial part of the total cost of stocking a pond with trout from a commercial hatchery is the cost of transporting them from the hatchery to the pond. If he has the facilities, the owner can save himself this part of the cost by doing his own transporting. Thoroughly clean milk cans are a satisfactory container for this operation, although larger types of tanks, with covers, are even more efficient if available. The transporting should be done in cool to cold weather in spring or fall. If there is any question that water temperature in the tank might be raised above 55° F. during transit, it is well to pack ice around the containers. *If ice is to be placed in the water used for carrying fish, it is absolutely essential that this be ice made from non-chlorinated water, since very minute quantities of chlorine will kill the trout.* Another aid to transporting fish is to provide a means for replenishing the oxygen supply in the water as it is used up by the fish. This is most easily accomplished by using chemical preparations, commonly sold in round flat tins about the size of a quarter, which when immersed in the water, release oxygen in small bubbles. These are generally available from stores that supply fishing tackle. Directions for use are on the container. It is wise to plan on using one or two of these "tablets" in each milk can. Although a tablet may last much longer than one hour, it is best not to depend on this. Check with your hatchery man in advance to arrange a specific date for picking up the fish. He can advise how many containers of a given size to bring for your particular situation.

[5]A directory of district fisheries managers for the various counties of New York State is given on page 31 of this bulletin.

When stocking the trout, place the milk can in the pond and tip it gently on its side so that the fish can swim out. The fish should be planted in a part of the pond as far removed as possible from any overflow structures.

Kinds of Trout

Brook trout (figure 4) or rainbow trout (figure 5) are equally suitable for New York farm ponds as far as growth and survival are concerned. Many people consider the brook trout to be better eating. Brook trout

Figure 4. Brook trout.

Figure 5. Rainbow trout.

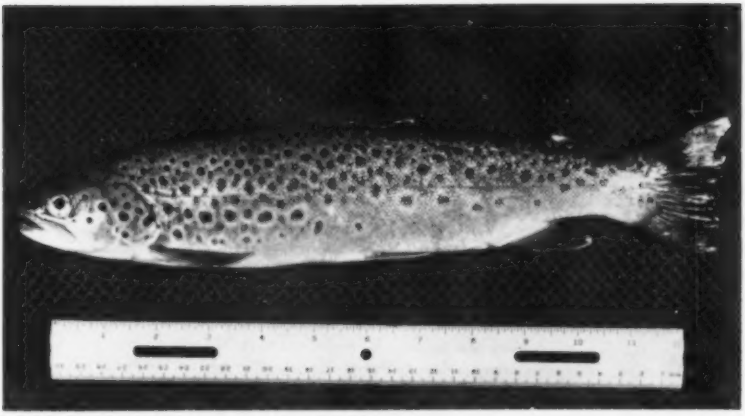

Figure 6. Brown trout.

are generally easier to catch than the rainbows. Although neither species is difficult to catch in the cooler months of the year, it is easier to harvest a very high proportion of a brook trout population than of rainbows. On the other hand, rainbow trout are generally considered to be somewhat more spectacular fighters than brooks. A mixture of these two kinds of trout can be stocked in a farm pond to provide greater variety of fishing.

If both kinds of trout are stocked, it is best to have them roughly the same size so that one group cannot prey on the other. For example, it would be unwise to stock six- or seven-inch rainbow trout in combination with two- or three-inch brook trout. The Fish and Wildlife Service can supply only brook trout or rainbow trout, depending on which species happens to be available, but not a mixture.

Brown trout (figure 6) *have proved unsatisfactory in New York farm ponds* because they are much harder to catch than either brooks or rainbows, providing poor to indifferent fishing and a low yield on the investment. Also, the old brown trout remaining in a farm pond prey heavily on any fingerlings introduced for restocking.

Trout are unable to compete successfully with most other kinds of fish, and if other species (with very rare exceptions) are present the pond will soon become practically useless for producing trout. This is chiefly because the other kinds of fish multiply rapidly in the pond and monopolize the food, so that the trout are literally starved out. After the contaminating species have become abundant, repeat plantings of trout produce practically no trout fishing because trout survival is so poor under these condi-

tions. There are a very few kinds of minnows which are not so prolific, never exceed a size of two or three inches, and may not interfere with trout production. Although these minnows may constitute a source of food for some of the larger trout, they also compete for the insects on which trout feed most, so that they probably add little if anything to net trout growth. No minnows of any kind should be stocked in farm ponds used for trout, since it is usually impossible to obtain a group of the 'harmless' minnows without also getting at least a pair or two of some other kind of fish. These will utimately ruin the pond for trout production until the entire fish population is killed off and a new trout population has been established.

When to Stock

Results obtained from farm pond plantings of spring fingerlings are highly variable, and hence unpredictable. For this reason, *it is best to to use fall fingerlings for trout stocking in New York ponds.* Either spring or fall fingerlings will reach catchable size by the following spring in most ponds.

When trout are obtained from a commercial hatchery, two- to three-inch fingerling trout usually sell for about $15 per hundred; five- to six-inch fall fingerlings $22 to $32 per hundred, although costs may vary with different hatcheries. At these prices, fall fingerlings will provide about 80 percent more catchable-size fish per dollar invested than will spring fingerlings in the average pond. It is very uneconomical to purchase trout larger than about six inches for farm pond stocking.

Trout should never be stocked near the time when high water temperatures can be expected in farm ponds. For this reason, spring fingerlings, if stocked at all, should be planted no later than May 1; fall fingerlings should be planted after September 30.

Number to Stock

Quantities of trout to stock are given as numbers of fish per acre of pond surface. Surface acreage of your pond may be available from calculations made when the pond was designed, or may be estimated by comparing your pond with another one of the same shape and size for which the surface acreage is known. If the pond is rectangular, the surface acreage can be calculated by multiplying the length in feet times the width in feet and dividing the product by 43,560. If the pond is circular or nearly so, measure the circumference of the pond in feet and square this number. The result, divided by 547,390, gives the approximate surface acreage. Areas of many ponds can be estimated from an aerial photograph or United States Geological Survey Map.

To obtain the maximum amount of fishing from a farm pond, the number of trout stocked should be that which will give the greatest poundage the pond can support without producing stunted fish. A stocking rate of 600 fall fingerlings (or 2,000 spring fingerlings) per acre is well within the carrying capacity of the average New York farm pond, and this is the rate which should be employed to produce the maximum yield of fish. Some New York farm ponds can be stocked at rates as high as 750 fall fingerlings per acre. Occasionally ponds located on exceptionally low-lime soils at high elevations may not give satisfactory growth when stocked with 600 fall fingerlings per acre. When this is the case, a stocking rate of 400 fall fingerlings will generally prove satisfactory.

Because of the abundance of ponds and the demand for trout, the Bureau of Sport Fisheries and Wildlife can furnish only 300 fall fingerlings per acre to owners of suitable farm ponds who apply for trout.

Fishing the Pond

Figure 3 (page 11) shows that most of the trout in an *unfished* farm pond will have died from natural causes by October of the second year after stocking. A pond owner should try to harvest as many of the trout as possible during these first two years.

The longer an owner waits before starting to harvest his trout, the lower the harvest will be. Trout pond owners often make the mistake of waiting a year or more after the fall stocking before starting to harvest their fish. They overlook the fact that, although the trout will be larger by this time, generally two-thirds or more of them will have died already. Consider the example of a Mr. Dow and a Mr. Jones, who start out with identical one-acre ponds each stocked with 600 fall fingerlings. The first year after stocking Mr. Dow harvests 165 fish. Mr. Jones does no fishing but waits to let his fish get larger. The second year both men fish equally hard, with equal success, and catch equal percentages of their remaining trout populations. Natural deaths occur at the same rate in both ponds. The numbers of fish caught and remaining in the ponds of Mr. Dow and Mr. Jones would be as follows:

	Mr. Dow		Mr. Jones	
	Caught	Remaining	Caught	Remaining
First year after stocking	165	115	0	230
Second year after stocking	35	5	70	10
TOTAL CATCH	205 (75 lbs.)		70 (50 lbs.)	

Table 2. Relation between number of trout per acre harvested in the first year, and number per acre that could be harvested in the second year after stocking. Average figures for ponds stocked at rates of 300 and 600 fall fingerlings per acre.

Number of trout per acre		
Harvested in first year	Available for harvest in second year	
	When stocking rate was:	
	300/acre	600/acre
0	35	70
50	25	60
100	15	50
150	5	40
200	—	30
250	—	20
300	—	10

Although Mr. Jones caught twice as many two-year-old fish as Mr. Dow, Dow's total catch for the two years was nearly three times greater in numbers and about 50 percent more by weight. Furthermore, the difference between numbers of fish left in the two ponds at the end of the second year was insignificant.

There is another good reason for fishing the pond as hard as possible the second year. The large two-year-old trout remaining in the pond when it is restocked will eat some of the newly-introduced fish. This predation will be kept to a minimum if, in the second year following a stocking, the owner makes every attempt to harvest all the old fish remaining, although it is unlikely that he will actually be able to eliminate them completely.

There is no basis for recommending what proportion of the trout should be caught the first year and what proportion the second. Bearing in mind the points brought out in the preceding paragraphs, each pond owner must formulate his own plan for harvesting. Table 2 gives the numbers of trout available for harvest in the second year, when various numbers were harvested the first year, for ponds stocked at rates of 300 and 600 fall fingerlings per surface acre. Since all of the figures given in this table are on an acre basis, you would need to reduce these figures proportionately according to the actual acreage of your pond.

As an example, take a half-acre pond stocked at the *rate* of 600 fall fingerlings per acre (number planted:300). The question: If, in the first year after stocking, I catch out a third of the number stocked, how

many can I expect to catch the second year if I try to fish out all remaining trout? First get the answer on an acre basis, then divide this by two for a half-acre pond, thus:

	One-acre pond	Half-acre pond
Number stocked	600	300
1st year's catch	200	100
2nd year's catch	30	15

Remember that the figures in table 2 are based on average trout survival in New York farm ponds. In any particular pond, the number of fish available for harvest the second year is likely to be higher or lower than that in the table.

Farm pond trout are generally much easier to catch in spring and fall than they are during the summer months, and it is unwise to plan on harvesting large numbers of them in the period from about mid-June to mid-September. Fly fishing, worm fishing, and spinning are among the methods that can be used to catch trout. The most successful method may vary with the season, and with the fisherman's particular skills.

New York farm ponds also afford opportunities for trout fishing during the winter months by fishing the deeper waters of the pond through holes chopped in the ice, using either worms or weighted artificial lures. The latter may often give best results when moved up and down in short jerks, a foot or two above the bottom.

Minnows should never be used for bait when fishing farm ponds. If minnows escape into the pond they may later reproduce and destroy its usefulness for trout production.

Farm Fish Pond License

Because efficient management of a trout pond involves harvesting sufficient numbers of them before they die of natural causes, it is particularly important that the trout pond owner obtain a farm fish pond license so that he can take advantage of the late fall, winter, and early spring fishing, when trout are readily caught but the regular trout season is closed. This license is available at no charge from the New York State Conservation Department and covers a period of five years, after which it can be renewed.

As stated in the Conservation Law, (section 358) the holder of a license or "any member of his immediate family, and any person actually employed by him in the cultivation of his farm or the management of the licensed pond may without license. . . take fish of any size, in any number, at any time, in any manner permitted by the Department." Persons other than those covered in the preceding statement must adhere to applicable

provisions of the Fish and Game Laws regarding seasons, licenses, and limits on numbers and sizes of fish taken from a farm pond. If the owner so requests, the Department may grant permission, in issuing this license, for the owner to take such measures as might be necessary to control undesirable kinds of vegetation, fish or other animals that interfere with the production of the desired species, or permission for the owner to stock his pond with fish from a commercial hatchery, as described on page 14.

Application for a farm fish pond license should be made to the district fisheries manager for your locality (listed on the back cover). Ponds that are not under individual ownership, such as those belonging to a club or other organization, are not eligible for a license, and in such ponds all of the applicable State Fishing Regulations must be observed. The same applies to privately owned ponds "...used in connection with any private camp, boarding house, hotel or other establishment catering to the public."

Trout that have been caught from a farm pond may be transported off the property of the pond owner, but only when certain regulations are observed. For these and certain other regulations concerning farm fish ponds, consult section 358 of the Conservation Law. This section also stipulates that any licensed farm fish pond must be posted against fishing without permission of the licensee.

Restocking

For repeat stocking of trout in farm ponds, *fall fingerlings should always be used*. Spring fingerlings, because of their small size, will suffer high mortality from predation by the few remaining "holdover" trout of the previous plant; fall fingerlings, usually four to six inches long, will be far less vulnerable to this predation.

Even in an unfished trout pond (stocked with 600 fall fingerlings per acre), about 50 fish remain two years after stocking, and only about 20 remain three years after stocking. Therefore ponds must be restocked every other year to provide adequate fishing.

The Fish and Wildlife Service cannot supply trout for a farm pond more often than every other year (at 300 fall fingerlings per acre), because of the heavy demand. Some pond owners might wish to stock 300 fall fingerlings per acre, purchased from a commercial hatchery, in the alternate years between plants of Federal fish. This management plan, while more expensive, will result in a more even mixture of one- and two- year old trout being present in the pond each year. When the pond is stocked every other year, trout available for harvest in a given year will be largely of one age group, alternating between yearlings and two-year-olds.

Feeding

There is no need to feed trout after they have been stocked in a farm pond. At the stocking rates mentioned above, trout grow rapidly on the natural food produced in the pond. Although supplemental feeding may increase the trout growth by perhaps an inch or two per year, the large majority of pond owners will find that feeding is a rather expensive pastime in view of the results obtained.

Pelleted trout food is available from farm supply stores. If a handful of these pellets is scattered in one particular area of the pond every day or two, trout often form the habit of coming to the surface for pellets whenever they are tossed in.

If feeding is to be done, care must be taken to avoid introducing more food in the pond at any one time than the fish will eat immediately. Unused food will accumulate on the bottom, decompose, and this decomposition process may build up to such a point that it dangerously depletes the oxygen supply in the pond water. If this happens, the entire trout population may be lost through suffocation, as described in a later section.

Fertilization

One application of inorganic fertilizer at a rate of 300 pounds per acre can be applied to a newly-dug pond as it is starting to fill. This practice appears to be safe, and although not a necessity it may somewhat hasten the establishment of a natural food supply in new ponds.

Severe or complete trout kills occasionally have occurred in farm ponds a week or two after heavy applications of inorganic fertilizer. It appears that in large doses the fertilizer itself sometimes may be harmful to the trout, although the exact effects are not known.

Small quantities of inorganic fertilizer, up to about 300 pounds per surface acre per year, generally can be applied to farm ponds without producing immediate harm to the trout population, and usually increase trout growth somewhat. However, *light fertilization (or barnyard drainage) usually stimulates heavy weed growth* in the pond, instead of producing a "bloom" of microscopic plants which might keep out the sunlight and thus retard weed growth. Large amounts of weeds make a pond practically useless to the owner. Also, when such quantities of vegetation die, the decay process may use up all the oxygen in the pond water, thus killing the fish. This is most likely to happen after the pond is frozen over for the winter.

In summary, fertilization heavy enough to retard weed growth is likely to result in direct harm to the trout, whereas applications light enough

to be harmless usually produce heavy weed growth, which in turn can be a danger as well as a nuisance.

Clearing Muddy Water

If the pond water is still muddy with suspended clay three months after it has filled, this condition usually can be corrected by adding *ground agricultural limestone* (calcium carbonate) to the pond. This material is commonly available in bulk quantities from farm supply stores. Although the exact amount required varies with the alkalinity of the pond and its watershed, an application rate of 1,000 pounds per acre will usually suffice. The benefits can ordinarily be expected to last at least two or three years, and in some cases no further applications will be required. There is no danger of an "overdose" of the limestone, because it is harmless and in fact tends to increase the pond's productiveness. Other chemicals, such as gypsum and alum, will also settle out suspended clay, but these substances tend to acidify the pond water. Acid water is undesirable for trout production.

Do not use lime (calcium oxide) which may kill the fish.

Eliminating Undesirable Fish

When a pond has become contaminated with fish species other than trout, it is necessary to eliminate these contaminants in order to obtain satisfactory trout production.

There are two general methods of accomplishing this. One method is to drain the pond *dry*, so that all of the contaminating fish are killed. If the pond has a drain pipe, this may be fairly easy to accomplish. If not, it may be possible to drain the pond by siphoning, if any permanent water supply can be temporarily cut off and sufficient non-collapsible hose of at least two inch diameter is available. If the owner has access to a large pump that can be operated for long periods of time, it may be practical to pump the pond dry if it is not too large.

If the pond cannot be drained, then it may be possible to eliminate all fish in the pond with rotenone, a compound commonly marketed as an insecticide which, in very low concentrations, kills fish by stopping blood circulation through the gills. In the concentrations used for killing fish, rotenone is entirely harmless to man and animals *except* for swine, which might be poisoned by drinking treated water. Information on the toxicity, if any, of carriers used in liquid rotenone preparations should be available from the manufacturer. Fish killed by rotenone are entirely safe to eat providing they are fresh. The concentrated rotenone compounds used for mixing with the pond water may be irritating to the skin or mucous

membranes, and you should therefore avoid prolonged contact with the concentrates.

It is *illegal* to use retenone in any body of water without first obtaining permission to do so from the fisheries manager of your district. Special permission must be obtained each time it is necessary to poison a pond. When the pond has water regularly flowing out of it into some other water body such as a stream or lake, it is likely to be difficult or impossible to obtain permission to use rotenone, and in such cases it may be necessary to employ the draining method discussed previously.

In many situations, it may be most practical and economical to use a combination of draining and rotenoning. To do this, a pond is drained as far down as possible. *After* the draining operation has been stopped, the remaining water is immediately treated with rotenone. If most of the pond water can be drained off, only the small remainder need be rotenoned. If the treatment is made during hot weather when rotenone loses its toxicity more rapidly, it is quite possible that by the time the pond has filled to the point of overflowing again, the water will no longer be toxic and will not endanger fish in the adjacent watershed. This of course assumes that no more rotenone is used than is necessary to treat water remaining after drainage, and at least one week elapses between time of treatment and the time the pond has filled again. However, there is no way of being certain that this method will safeguard the fish in connecting waters until the pond water itself is demonstrated to be non-toxic by testing with live fish of the desired species suspended in a cage at mid-depth near the pond outlet. This test should always be made before restocking any pond treated with rotenone. The effects of rotenone treatment in a farm pond may last only a few days, or may persist for several months, especially in winter.

Rotenone is available in two forms. One of these is a powder, commonly marketed in farm supply stores for insect control, containing four percent or five percent rotenone and about twelve percent total cubé resins. One four-pound bag, with one cup of detergent added to facilitate mixing, is enough to treat a one-fourth acre pond. Place the powdered rotenone in a container, mix in the detergent, and then add water gradually with continual stirring to avoid lumps until a very loose batter is obtained. This is then applied to the pond with a pressure sprayer of at least three gallons capacity. Rotenone is also available as an emulsifiable liquid in several commercial preparations. It is easier to apply than the powdered form, but the minimum quantity available for sale is five gallons. One gallon of the emulsifiable rotenone, at the five percent strength normally marketed, will treat six acre-feet of water, about the volume of an average

one and one-half acre farm pond with a maximum depth of eight feet. All rotenone concentrates, whether powder or liquid, tend to lose their toxicity with exposure to air and high temperatures. When a concentrate has been partly used and then stored for several months, the remainder is likely to have lost much of its usefulness as a fish poison.

It is essential that the rotenone be dispersed throughout the entire pond in order to insure a complete kill of fish. For this reason, it is best to apply rotenone in April or October, when water temperatures are cool. A windy day also helps mixing of the pond water. In ponds up to one-third acre in size, the rotenone can be applied from shore, making sure to get fairly uniform distribution of the spray material over the entire pond surface. In larger ponds, the rotenone should be sprayed from a boat, applying about half the material over the pond surface; the remainder in the deeper water, with the sprayer nozzle held as far below the surface as possible.

Farm Pond Pests

Aquatic weeds or scums (algae) will usually reach nuisance proportions in any farm pond sooner or later. Methods for controlling the various types of farm pond weeds are described in Cornell Extension Bulletin 1014. It should be noted here that small amounts of rooted aquatic plants are likely to increase trout production in farm ponds by providing shade, which tends to keep summer water temperatures lower, and by providing more suitable habitat for aquatic insects, which increases the supply of trout food and makes for faster growth.

Except for undesirable fish species, there is only one animal, the muskrat, that is a serious pest in New York farm fish ponds. Muskrat control is discussed in the following section. Following this is a section devoted to other kinds of animals often found in farm ponds, their effects on trout management, and control methods, if any, that should be used.

Muskrats[6]

Muskrats damage ponds by burrowing into the banks. The burrow starts about six inches below the water line, slopes upward and is usually four to five feet long. Such burrows may cause leaks and dangerous amounts of erosion. When the burrows collapse these problems are magnified. Extent of the muskrat damage will increase with time if the animals are not controlled.

If possible, the prospective builder should locate his pond in an area

[6]Prepared by Howard R. Erickson, Department of Conservation, Cornell University.

well removed from other water bodies, including streams, which are potential sources of muskrat infestation.

Whether muskrats are present or not, the pond banks should be kept mowed so that if damage occurs it can be readily seen and promptly corrected. Mowing also reduces the amount of protective cover for muskrats. Cattails and other emergent vegetation should be removed from the pond, since these plants provide both food and cover.

Muskrats should be removed at once when there is evidence that they are damaging a farm pond managed for trout production. They are most likely to move in during the spring or fall, when the official trapping season is usually closed. The simplest approach is to obtain a 'rider' on your Farm Fish Pond License authorizing you to trap muskrats from your pond at any time for nuisance control purposes. A pond owner who does not have a Farm Pond License can obtain a *temporary* trapping permit from his district game manager.

Steel traps[7] are relatively inexpensive, and effective if set properly. Of these, the "stop-loss" or "killer" models are more efficient although more expensive. Number one and one-half or number two traps should be used.

Cage-type live traps that have spring action doors can be used effectively by individuals inexperienced in trapping techniques to remove entire pond populations of muskrats. The traps are baited with carrot slices. Although the cost per trap is several times greater than steel traps, only a few live traps are necessary to effectively trap a pond, and since they catch the muskrats alive the pond owner can release the animals at some distant point if desired.

If a pond is constantly invaded and damaged by muskrats from nearby water areas, or if the dike is especially narrow, the pond owner may wish to rip-rap his shoreline with small rocks or heavy gravel. These materials should be extended at least one foot above normal water level and at least three feet below it in a layer about three inches thick. Areas treated with a properly constructed barrier have complete and lasting protection from muskrats. The barrier also protects the shoreline against wave erosion and improves the area for swimming.

Miscellaneous Pond Animals

Frogs, salamanders (newts), or sometimes both, are common in most farm ponds. Strangely enough, neither frogs, tadpoles, or salamanders are found in the stomachs of farm pond trout except on very rare occasions. These animals are entirely harmless to humans and are a natural

[7]This is the type consisting of two steel 'jaws' that snap shut.

and interesting part of any aquatic environment. There is no practical way of eliminating them from the pond that would not also eliminate the fish. Furthermore, even after total eradication of the frogs and salamanders in a pond, it would very soon become repopulated. Although frogs and salamanders consume a portion of the pond's plant and animal life that might otherwise become trout food, their effect on management of a pond for trout fishing is negligible. Furthermore, they serve an important function as food for various predatory birds and reptiles that may visit the pond and which, without this ready source of food, might make more serious inroads on the trout population.

Occasionally water snakes take up residence near a trout pond, although this is common only in ponds located close to streams. To date there is no evidence that these snakes noticeably affect farm pond trout populations, although they do eat fish. Water snakes are less docile than some other kinds and may strike if cornered and sufficiently provoked. However, they are non-poisonous and the bite is harmless.

Snapping turtles occasionally inhabit larger farm ponds, and in a few instances they have been known to do some damage to trout populations. Snappers can be distinguished from other turtles by the saw-tooth rear edge of the upper shell. Other kinds of turtles are much more common in New York farm ponds, and are entirely harmless. Information on pond turtles and their capture is found in *Turtle Trapping*, Fishery Leaflet 190, available from the United States Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Washington 25, D. C.

Fish-eating birds such as herons and grebes are occasional visitors to farm ponds. As far as is known, most of these birds do not seriously affect the numbers of trout in a farm pond, with the exception of the great blue heron. There have been occasional instances of ponds well removed from roads or buildings where these herons have killed moderate numbers of trout, and inflicted wounds on many of the remainder. However, it is virtually impossible for herons to come even close to eliminating a trout pond population unless the pond is extremely small and shallow. Herons and grebes are protected under Federal Law. Requests for information or assistance on protecting a pond from these birds should be directed to a United States game management agent. There are three agents in New York State, located at Bellport (Long Island), Walden, and Wolcott.

By far the most damaging bird predator in New York farm ponds to date has been a domestic variety, the Muscovy duck. In farm ponds where Muscovies have been present, trout survival over a five month summer period has frequently been as low as ten percent, and never more than thirty percent. If it is necessary to give these ducks access to a trout pond,

they should be fenced and wing-clipped so that their activities are confined to a very small fraction of the total pond area.

Moles are occasional farm pond pests. By their tunnelling activities they may destroy patches of the sod cover on pond banks which lead to erosion if not controlled. Mole control by trapping, and information on the habits of moles are presented in Cornell Extension Bulletin 729. Moles also may be successfully killed by the use of poisoned bait. A product, "TAT Mogo," consisting of raw Spanish peanuts treated with one percent thallium sulphate, has been effective. Three or four of the treated peanuts are dropped into tunnel openings made by probing into active runways at intervals of several feet.

Fish Kills

Occasionally a partial or complete kill of trout occurs in a farm pond, and the owner is naturally anxious to determine the cause. It is frequently difficult or impossible to determine with certainty the cause of a fish kill. However, information is given in this section which may assist a pond owner in making an "educated guess" about the cause of a trout kill, together with suggestions on how to lessen the chances of certain types of kills.

Oxygen Depletion

For respiration fish depend entirely on the oxygen that is present in dissolved form in the water. If the dissolved oxygen content of the water becomes too low, the fish suffocate. Fish kills from this cause are usually characteristic. All or most of the fish are affected at the same time, and can be seen struggling and gasping at the surface. Often fish that have died from this cause have the mouth open and the gills flared out. Kills from oxygen depletion most commonly occur toward the end of the night, often between 4:00 a.m. and 8:00 a.m. This is because plants growing in the pond produce oxygen during the daylight hours, but at night they reverse the process and use up the oxygen. This, coupled with other demands on the pond's oxygen supply, usually results in the oxygen content reaching its lowest point at the end of the period of darkness.

In addition to oxygen used by the animals in the pond, and by the living plants at night, the decay process also uses up large amounts of oxygen. Too much decomposing animal or vegetable matter in the pond at one time may reduce the oxygen supply below the point that trout can tolerate. During the winter months when ponds are ice-covered, ponds must depend for their oxygen on that contained in inflowing water and that produced by any living plants, since there is no opportunity for oxygen to be absorbed from the air at the pond surface.

Kills from oxygen depletion, either in summer or winter, are uncommon in New York trout ponds except those which are heavily fertilized either artificially or from barnyard drainage. The chances of a trout kill from oxygen depletion can be lessened by avoiding fertilization and by controlling weed growths, particularly in the autumn months.

High Water Temperature

When water temperatures throughout a pond remain too high for trout for more than a few days, trout will begin to die. Under these circumstances, a progressive rather than a sudden kill of trout generally occurs. At any particular time, some dead fish may be noted on the bottom or floating at the surface, and other fish will be seen behaving in an abnormal manner. Often these fish will appear to be very inactive or sluggish, or may be swimming in slow circles or with a spiralling motion.

Because high temperature kills are often gradual, and because carcasses that float usually drift ashore and are soon disposed of by racoons, skunks, and other animals, it is possible for a large or even complete temperature kill to take place without the owner's knowledge. For this reason, failure to observe dead fish does not necessarily mean a kill has not taken place.

Toxic Substances

Occasionally trout will be killed by the introduction of poisonous materials into the pond. Such substances include, among others, various insecticides (particularly rotenone, DDT, Dieldrin, and Endrin), sprays containing a large amount of copper, and chemicals containing chlorine. Symptoms exhibited by the dying fish vary according to the kind and amount of toxic material introduced.

To avoid kills from such causes, the above-mentioned insecticides should not be used on the pond watershed, and equipment used for applying these and other sprays should never be filled, emptied or rinsed in the pond or tributaries to it.

Relation of Other Pond Uses to Trout Management

Swimming in no way interferes with a farm pond's use for trout production, except in rare instances when so much swimming is done that the pond water is kept continually muddy. In such cases growth of the trout may be slowed somewhat.

Use of the pond water for livestock or for spraying will not conflict with trout management providing that water for these purposes is taken from a tank located outside the pond and fed by a pipe, and providing also that these uses do not result in decreasing the maximum pond depth below eight feet.

A trout pond can also be used for irrigation if sufficient water depth is maintained, as mentioned above. When water is to be pumped from a pond, the intake should be located near the surface, and should be surrounded by a screen or a rock filter.

Commercial Management of Trout Ponds

Sometimes individuals become interested in the possibility of operating a trout pond for financial profit.[8] At present there is practically no information available from actual trials of such ventures in New York State. However, certain general considerations and precautions can be mentioned in this connection.

For any kind of commercial operation, the owner should obtain as much detailed information as possible about the actual profits he can expect. For this, he would need accurate information on the existing or potential market for his product. Using the average figures on growth, survival, and prices of trout given in this bulletin, the owner can estimate the trout cost and production to be expected. He should try to determine as accurately as possible the profit he might realize, taking all of the above factors into consideration, along with the cost of the pond and its maintainance. For high production, it is possible that higher stocking rates than those given here can be employed, particularly if the crop is being heavily and fairly continuously harvested.

For a number of reasons New York trout ponds, as defined in this Bulletin, are not well adapted to rearing and harvesting trout for sale as a table delicacy to restaurants, hotels, and the like. If trout ponds can be successfully managed as a profit-making venture, it appears most likely that this management will be in the form of offering trout fishing for a set fee, or a certain price per trout caught, or perhaps a combination of the two. Operation of a trout pond for this purpose (referred to in the Conservation Law as a "fishing preserve") requires an annual license from the Conservation Department ($25.00 fee), and no trout from Federal or State hatcheries can be employed in such a venture. There are a number of detailed regulations concerning operation of fishing preserves, particularly with regard to fishing, transporting fish caught, and maintenance of records and submission of reports by the operator. A pond owner considering embarking on a fee fishing venture should become thoroughly acquainted with Section 359 of the Conservation Law.

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[8]A useful reference on this general topic is *Fish Culture as a Livelihood*, Fishery Leaflet 97, available from the United States Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Washington 25, D. C.

District Fisheries Managers of The New York State Conservation Department

District and Office	Counties in District	
ADIRONDACK		
R. G. Zilliox, District Fisheries Manager New York State Conservation Department Ray Brook, New York Phone: Saranac Lake 821	Clinton Essex Franklin	Hamilton Warren Washington
CENTRAL		
A. C. Petty, District Fisheries Manager New York State Conservation Department 35 South Broad Street Norwich, New York Phone: Norwich 4-3113	Broome Chemung Chenango Cortland Delaware Fulton Madison	Montgomery Onondaga Otsego Saratoga Schenectady Schoharie Tioga
ONTARIO–ST. LAWRENCE		
D. G. Pasko, District Fisheries Manager New York State Conservation Department Box 84, Theresa Road Watertown, New York Phone: Watertown, Sunset 2-2780	Herkimer Jefferson Lewis	Oneida Oswego St. Lawrence
SOUTHERN		
J. D. Gould, District Fisheries Manager New York State Conservation Department 105 Dutchess Turnpike Poughkeepsie, New York Phone: Poughkeepsie—Globe 4-7901	Albany Bronx Columbia Dutchess Greene Kings Nassau New York Orange	Putnam Queens Rensselaer Richmond Rockland Suffolk Sullivan Ulster Westchester
WESTERN		
Dr. U. B. Stone, District Fisheries Manager New York State Conservation Department 2130 Scottsville Road Scottsville, New York Phone: Rochester, Beverly 5-3078	Allegany Cattaraugus Cayuga Chautauqua Erie Genesee Livingston Monroe Niagara	Ontario Orleans Schuyler Seneca Steuben Tompkins Wayne Wyoming Yates

Other Cornell Publications on Farm Ponds

Farm Ponds in New York, Carl S. Winkelblech, Cornell Extension Bulletin 949, December 1955.

Raising Bait Fish and Crayfish in New York Ponds, J. L. Forney. Cornell Extension Bulletin 986, September 1957.

How to Control Weeds and Algae in Farm Ponds, A.W. Eipper and H. B. Brumsted, Cornell Extension Bulletin 1014, March, 1959.

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